datalogger for DMM

for Metex & Voltcraft DMMs

As you may know, the combination of a PC and a Metex or Voltcraft DMM sporting a serial interface may be used as a recording oscilloscope provided you leave the PC switched on and connected all the time. Because that it not always possible or desirable, we present a datalogger system that can make do without the PC.

Features

- *Simple to operate*
- *High accuracy*
- *Supports all DMM measurement ranges*
- *Compatible with Voltcraft and Metex DMMs*
- *Data readout on internal LCD*
- *Simple construction, low cost*

Technical data

Supply voltage	
Mains adaptor	*9-12 V*
Battery	*9 V PP3*
Average current drain	*6.5 mA*
Serial protocol (PC link)	*1200/8/n/2* *9600/8/n/2*

Design by R. Lock

Some of the latest digital multimeters (DMMs) have an extremely useful function: a serial interface. By linking this to a PC, you get a recording oscilloscope for slow signals. On the down side, the PC then has to be present at the measurement location, and left running all the time. Besides, the DMM occupies the serial port during the entire measurement (which may take several days to complete). These disadvantages considerably complicate the use of the DMM as described, and limit its functionality.

The datalogger described here avoids these problems. It automatically captures the discrete measurement values supplied by the DMM, puts them in permanent storage, and, if desired, displays them on an LCD. Relatively large data volumes may still be transferred to a PC, for processing later using ‘big gun’ spreadsheet/statistics software like Excel.

Another marked advantage of the system as described is that the use of a multimeter ensures that all measurement ranges of the instrument in question are available with the relevant accuracy. Multimeters with special measurement options like temperature, power and so on further add to the versatility and appeal of the datalogger.

HARDWARE

As you can see from the circuit diagram in **Figure 1**, the datalogger is basically a ‘stand-alone’ microcontroller system based on the 80C31. The control program is stored in a type 27C256

1

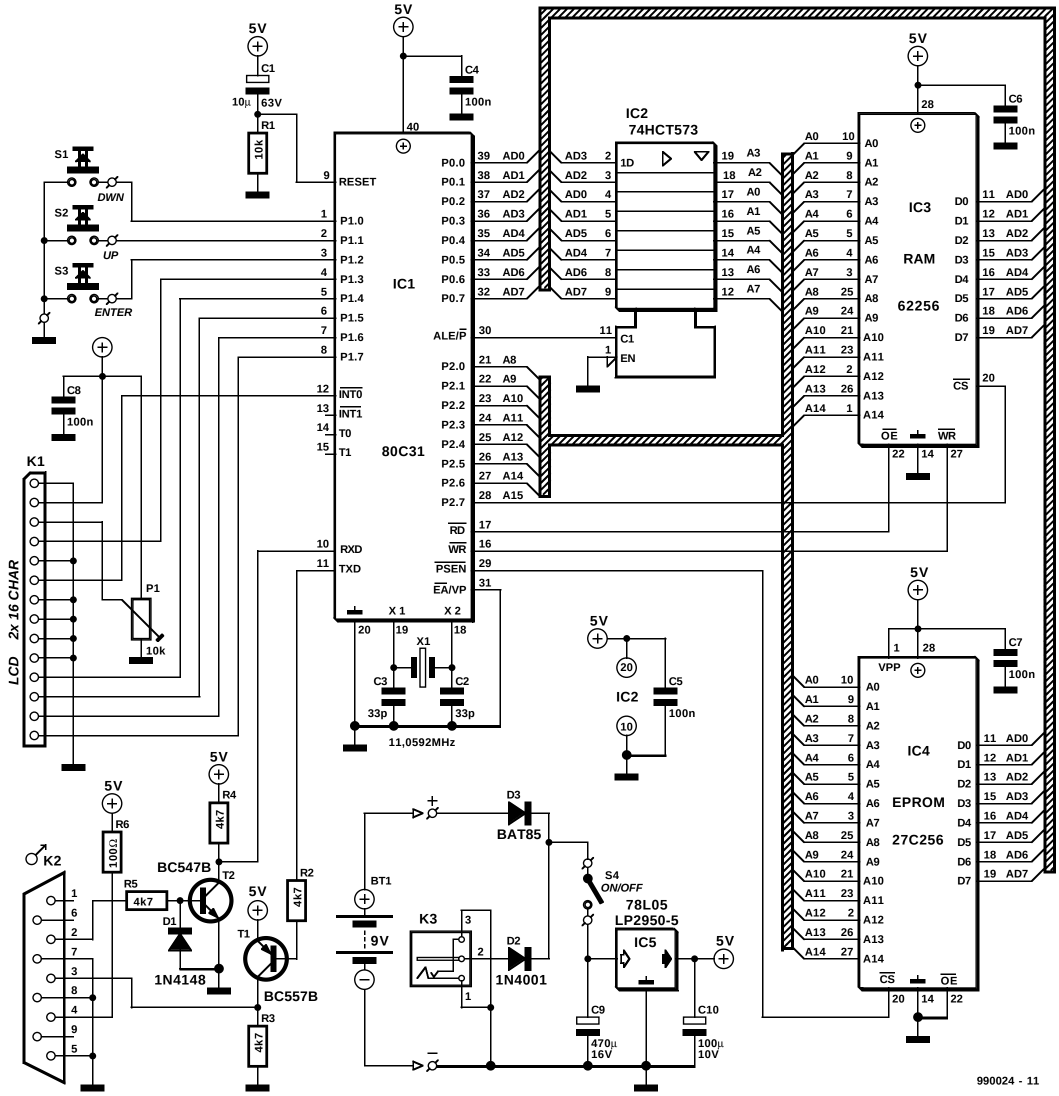

Figure 1. The datalogger consists of an 80C31 microcontroller system with RS232 and LCD interfaces.

EPROM with a size of 32 kBytes. A 62256 RAM with the same size is employed for storage of the measurement data. The microcontroller is clocked by an 11.0592 MHz quartz crystal. This frequency may seem odd, but is does allow standard baudrates to be derived easily. Network R1-C1 provides the power-up reset signal. The alphanumeric display is controlled in 4-bit mode via serial port 1.

The RS232 interface in the datalogger is a minimum-hardware design consisting of a transistor buffer/inverter on the TxD line and a level converter/inverter, also transistorised, on the RxD line.

The supply circuit allows the datalogger to be powered by a conventional mains adaptor. By means of diodes D2 and D3, an external battery is ‘OR-ed’ into the circuit, in parallel with the mains adaptor. When the output voltage from the mains adaptor fails, the battery takes over as the power supply. In this way, a no-break power supply is created, and no further measures are required to safeguard the RAM data against corruption by power disruptions. The low-drop voltage regulator type LP2950-5 can be relied upon to completely drain the battery to the last microamperehour. In case the datalogger is to be powered by the mains adaptor only, a more conventional fixed-voltage regulator like the 78L05 may be used. In the inactive state, the circuit draws a quiescent current of about 6.5 mA. With battery life in mind, it is fortunate that the average current drain of the datalogger is not much higher. When a measurement takes place, the current drain briefly rises to approximately 20 mA.

Operation

The first thing to do after switching on the circuit is adjust preset P1 until the text on the LCD is clearly legible. The first text to appear will be **`DMDLE12`**. The datalogger is operated with the arrow keys and the Enter key. The latter selects between the various menus, and confirms the selection of the menu options you can point to with the arrow keys.

To perform a measurement, connect-up the supply voltage, switch off the DMM, connect the datalogger to the DMM, and then switch the DMM on again. After starting the datalogger, you will see the menu options

```
 MAIN MENU
>Data retrieval
>Measuring
```

Having selected the option **`Measuring`** and having pressed the Enter key the following information appears on the display:

```
Sampling P 00:02
Enter minutes
```

You are prompted to enter the measurement interval (P); the highest value allowed is 99 minutes and 99 seconds. (99:99). Use the arrow keys to select the minutes value, then press Enter. This menu appears:

```
Sampling P 00:02
Enter seconds
```

2

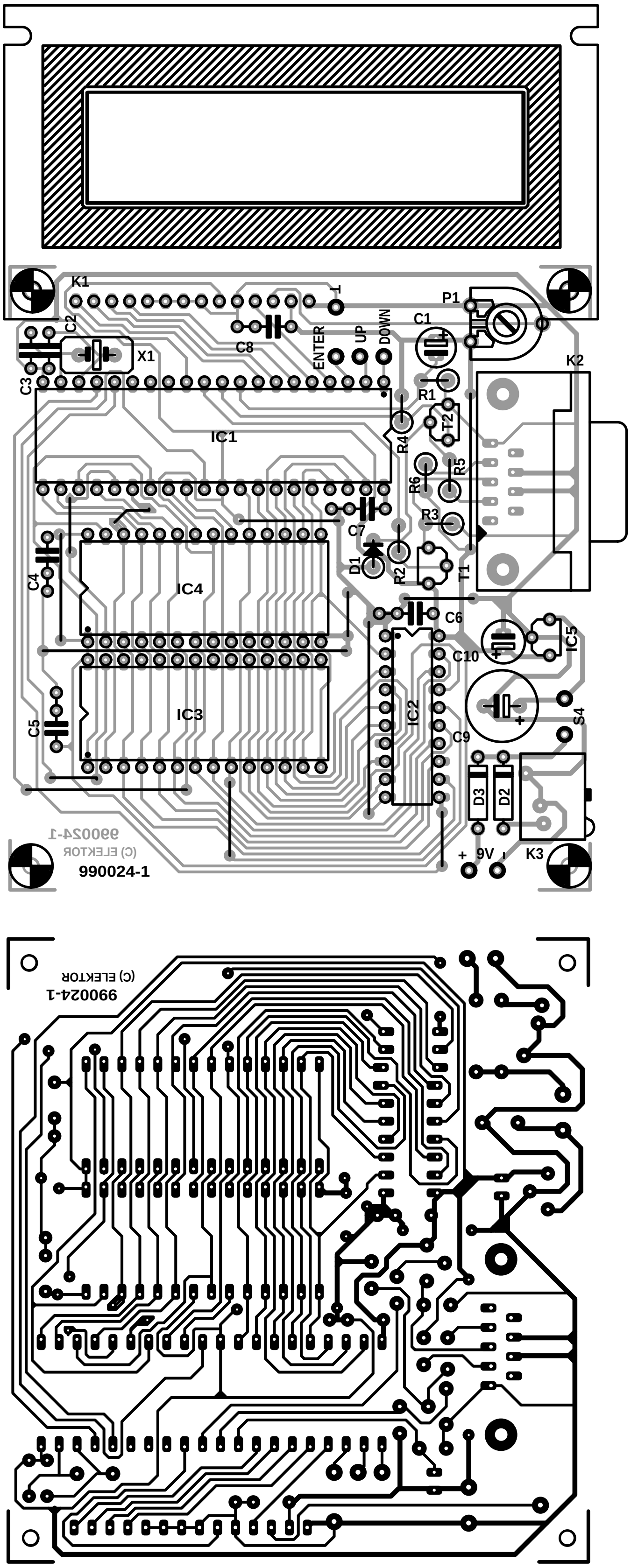

Figure 2. The printed circuit board is easily mounted in a case with a display window.

COMPONENTS LIST

Resistors:
R1 = 10kΩ
R2-R5 = 4kΩ7
R6 = 100Ω
P1 = 10kΩ preset

Capacitors:
C1 = 10µF 63V radial
C2,C3 = 33pF
C4-C8 = 100nF
C9 = 470µF 16V radial
C10 = 100µF 10V radial

Semiconductors:
D1 = 1N4148
D2 = 1N4001
D3 = BAT85
T1 = BC557B
T2 = BC547B
IC1 = 80C31, 80C51 or 87C51 (40-pin DIL case
IC2 = 74HCT573
IC3 = 62256 (e.g. UMC62256E-70LL)
IC4 = 27256 (order code 986522-1)
IC5 = 78L05 or LP2950-5 (see text)

Miscellaneous:
K1 = 14-way IDC connector for flat-cable
K2 = 9-way sub-D pinheader, angled pins, PCB mount
K3 = mains adaptor socket
S1 = pushbutton, 1 make contact, CTL3 (Multimec)
S4 = Slide switch, 1 x on
X1 = 11.0592MHz quartz crystal
Plastic case, approx. size 145 x 90 x 28 mm (Pactec type HP)
LC display, 2 lines of 16 characters, e.g., LTN 211 R-10 (Philips) or LM16A211 (Sharp)
PCB, order code 990024-1

Enter the desired no. of seconds of the measurement (sampling) interval, and press Enter again. The next prompt appears:

```
START          y
MEASUREMENT?   n
```

Press 'y' to continue. The first line of the display will then show the previously captured set of data, with the current measurement time on the second line, for example,

```
DC      00.00  V
        00:00:08
```

The clock continues to tick and is updated every second. The measurement value in the upper line is updated depending on the previously set sampling interval. The longest measurement period is 100 hours less one second.

If no multimeter is connected, the microprocessor will 'hang'. To start a measurement anyway, you press the Enter key.

A measurement may be ended by keeping the Enter key pressed for more than 1 s. Cancelling is confirmed when the display indicates

```
STOP
```

The last data set and the associated time mark are then 'frozen'. By pressing the Enter key again you are returned to the main menu.

Transferring measurement data

3

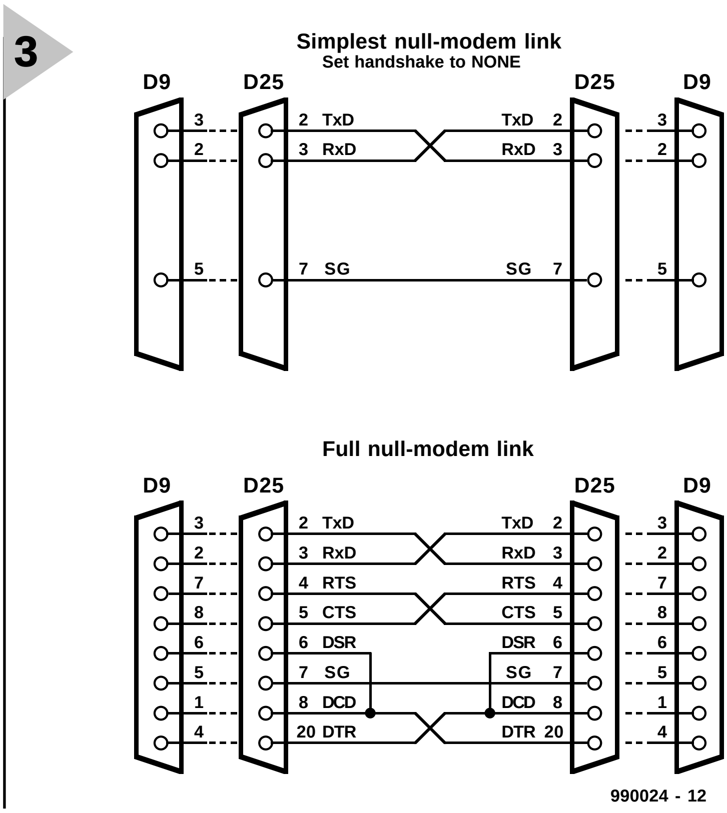

Figure 3. All about zero-modem cables.

from the datalogger to the PC is even simpler. In the main menu you select `Data retrieval`. By pressing the up/down arrow keys you call up the following options:

```
>> Display
>> PC numerical
>> PC alphanum.
```

Selecting the first option causes the measurement values to be shown on the datalogger LCD, with the arrow keys available to scroll through the data sets.

The other two options cause the data sets to be sent to the PC, either in numerical or alphanumerical format. Before that can be done however, you have to select the data speed in this menu

```
>>> BAUDRATE
>>> 1200 baud
>>> 9600 baud
```

Once that has been done, you may launch the data upload operation by confirming the option

```
Output - -> PC
```

CONSTRUCTION

The design of the printed circuit board shown in **Figure 2** is pretty spacious, so constructing the datalogger and fitting it in a ‘windowed’ plastic case should not present undue difficulties.

All ICs may be fitted in sockets. Do not forget the 13 wire links on the single-sided board, and make sure all parts are mounted the right way around. With everything in place, give the board a thorough visual check, looking for cold joints and solder splashes.

CONNECTING-UP

The DMM and the PC are hooked up to one and the same the 9-way sub-D connector on the datalogger board, but not simultaneously, of course. Like the serial port connector on a PC, this connector is a plug, so that the DMM is easy to connect. Connecting the PC however requires a special cable: it should have sockets at both ends, as well as crossed TxD, RxD and handshaking lines. The construction of this so-called *null-modem* (or *zero-modem*) cable is illustrated in **Figure 3**.

DMMs with an RS232 interface are designed for direct connection to a PC. The serial interface on the PC may have a 9-pin or a 25-pin connector. In the first case, pin 3 is the output, and pin 2, the input. The pin numbers are reversed on the 25-way connector! This is taken into account in the serial cable for the multimeter, no matter if a 9-pin or 25-pin connector is used.

Basically there is only one-way data traffic between the PC and the datalogger. The DTR signal on pin 4 (DB25: pin 20) of the PC connector indicates that the PC is ready to receive new data. The same applies to the RTS signal on pin 7 (DB25: pin 4), which is activated by the PC to indicate that it wants to send data. Because many digital multimeters require these two signals to be able to upload logged data to a PC, pin 4 of K2 on the datalogger is started to +5 V, while pin 7 is connected to ground.

At the PC side, you may use just about any communications program, including the popular HyperTerminal utility which comes with Windows 95. Select the COM port and the following communication parameters: 1200 bits/s or 9600 bits/s, 8 databits, no parity, 2 stop bits and *hardware* protocol. A zero-modem cable with no more than the two data lines and ground will also work. The datalogger does not employ handshaking, so you select *none* for the protocol. Incidentally, the data exchange between the datalogger and the DMM employs a different communications protocol: 7 databits, no parity, and 2 stop bits.

The author used the datalogger in combination with a Metex M-3610-D and a Voltcraft VC 506. The prototype circuit built in *the Elektor Electronics* design lab was successfully tested with a Metex M-3650-CR. Other DMMs of the same two brands can be expected to support the same protocol.

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